

# Package ‘ecochange’

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**Type** Package

**Title** Integrating Ecosystem Remote Sensing Products to Derive EBV Indicators

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## Description

Essential Biodiversity Variables (EBV) are state variables with dimensions on time, space, and biological organization that document biodiversity change. Freely available ecosystem remote sensing products (ERSP) are downloaded and integrated with data for national or regional domains to derive indicators related to structural EBV, including horizontal ecosystem extents, fragmentation, and information-theory indices. To process ERSP, users must provide at least a region of interest (polygon or geographic administrative data map). Downloadable ERSP include Global Surface Water (Peckel et al., 2016) <doi:10.1038/nature20584>, Forest Change (Hansen et al., 2013) <doi:10.1126/science.1244693>, and Continuous Tree Cover data (Sexton et al., 2013) <doi:10.1080/17538947.2013.786146>. The package relies on GDAL binaries. To instal GDAL in different operative systems, see the system-dependencies vignette.

**License** GPL-3

**Depends** R (>= 3.5.0), raster, rgeos, stats, ggplot2, sf, gdalUtils

## Imports

readr,rgdal,parallel,curl,gdalUtilities,graphics,rvest,landscapemetrics,sp,tibble,utils,xml2,dplyr,R.utils,htrr,getPass,method

**Suggests** knitr, rmarkdown, rasterVis

**SystemRequirements** GDAL binaries

**VignetteBuilder** knitr

**Encoding** latin1

**NeedsCompilation** no

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**Repository** CRAN

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## R topics documented:

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|                  |                          |
|------------------|--------------------------|
| barplot.EBVstats | <i>barplot EBV Stats</i> |
|------------------|--------------------------|

---

### Description

A barplot of [EBVstats](#) is printed.

### Usage

```
## S3 method for class 'EBVstats'
barplot(height,
  ...)
```

### Arguments

|        |   |
|--------|---|
| height | tibble of EBVstats.                               |
| ...    | Additional arguments in <a href="#">barplot</a> . |

### Value

Bar plot.

### Author(s)

Wilson Lara Henao <[wilarhen@gmail.com](mailto:wilarhen@gmail.com)> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
## Warnings from GDAL/PROJ are suppressed.

## Brick with structural Essential Biodiversity Variables covering the
## extent of a location in the northern Amazon basin (Colombia):

path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Tree-cover layers in the 'amazon' brick are both formatted and
## deforested:

suppressWarnings(
def <- echanges(amazon, eco = 'TC',
               change = 'lossyear',
               eco_range = c(1,80),
               get_unaffected = TRUE,
               binary_output = FALSE,
               mc.cores = 2)
)

## Deforestation Statistics:

defstats <- suppressWarnings(EBVstats(def))

## barplot method:

barplot(defstats)
```

---

EBVstats

*EBV Stats*


---

**Description**

This function is a wrapper of `cellStats` used to compute statistics of essential biodiversity variables.

**Usage**

```
EBVstats(ccp, stats,
        ...)
```

**Arguments**

|                    |  |
|--------------------|--|
| <code>ccp</code>   | RasterStack or NULL. If NULL then NULL is returned.  |
| <code>stats</code> | character. vector of stats defined in <code>cellStats</code> . If missing then six summary statistics, including 'mean', 'sd', 'min', 'max', are computed. |
| <code>...</code>   | Additional arguments in <code>cellStats</code>   |

**Value**

tibble.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
## Warnings from GDAL/PROJ are suppressed.

## Brick with structural Essential Biodiversity Variables covering the
## extent of a location in the northern Amazon basin (Colombia):

path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Tree-cover layers in the 'amazon' brick are both formatted and
## deforested:

suppressWarnings(
  def <- echanges(amazon, eco = 'TC',
                 change = 'lossyear',
                 eco_range = c(1,80),
                 get_unaffected = TRUE,
                 binary_output = FALSE,
                 mc.cores = 2)
)

## Deforestation Statistics:

defstats <- suppressWarnings(EBVstats(def))

## barplot method:

barplot(defstats)
```

---

echanges

*Ecosystem changes*

---

**Description**

This function produces ecosystem-change maps by masking cell values in a layer of ecosystem changes over a target set of ecosystem variables. The function allows focusing the ecosystem-change analysis on a species distribution range.

**Usage**

```
echanges(ps, eco = names(ps[[1:(nlayers(ps) -
1)]]), change = names(ps[[nlayers(ps)]]),
sp_dist, eco_range = c(1,
100), change_vals = 1:19,
sp_dist_range = c(1,
1), spread = TRUE,
get_unaffected = TRUE,
binary_output = FALSE,
noDataValue = 0,
mc.cores = round(detectCores() *
0.6, 0), ...)
```

**Arguments**

|                             |   |
|-----------------------------|---|
| <code>ps</code>             | RasterStack or SpatialPolygonsDataFrame. Stack of spatial data, including the target ecosystem variables, a layer of changes, and an alternative layer of a species distribution range. This argument can also be a polygon geometry used to integrate such spatial data via implementation of <a href="#">rsp2ebv</a> ; see the ellipsis term below. |
| <code>eco</code>            | character. Regular expression matching names of a subset of layers representing the target ecosystem variables. Default matches names of the first 1:(n-1) layers in <code>ps</code> .  |
| <code>change</code>         | character. Name of the layer of ecosystem changes. Default matches the name of the last layer in <code>ps</code> .  |
| <code>sp_dist</code>        | character. Name of an alternative layer representing a species distribution range. If missing then this argument is ignored.  |
| <code>eco_range</code>      | numeric. Range of values in the target ecosystem variable.  |
| <code>change_vals</code>    | numeric. Vector of values in the layer of ecosystem changes.  |
| <code>sp_dist_range</code>  | numeric. Range of values in the alternative layer of species. distribution range. This argument is ignored if <code>sp_dist</code> is missing.  |
| <code>spread</code>         | logical. Spread representation of ecosystem changes. Users do not need to change this argument. It is used by other routines to fastening computation of ecosystem horizontal extents. If FALSE then the function mask cell values in the target ecosystem variables over over the layer of ecosystem changes. Default TRUE.                          |
| <code>get_unaffected</code> | logical. Extract unaffected areas. If FALSE then pixel values of the ecological variable across the changed areas are extracted. Default TRUE.  |
| <code>binary_output</code>  | logical. Produce binary outputs (masks). If FALSE then ranges of values of the ecological variable are maintained. Default FALSE.   |
| <code>noDataValue</code>    | numeric. Output NoDataValue. Default 0.   |
| <code>mc.cores</code>       | numeric. The number of cores. Default uses around 60 percent of the CPU capacity.   |
| <code>...</code>            | If <code>ps</code> is a polygon then additional arguments in <a href="#">rsp2ebv</a> .  |

**Value**

RasterBrick.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**References**

Jetz, W., McGeoch, M. A., Guralnick, R., Ferrier, S., Beck, J., Costello, M. J., ... & Meyer, C. (2019). Essential biodiversity variables for mapping and monitoring species populations. *Nature Ecology & Evolution*, 3(4), 539-551.

Pekel, J. F., Cottam, A., Gorelick, N., & Belward, A. S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature*, 540(7633), 418-422.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. *science*, 342(6160), 850-853.

Sexton, J. O., Song, X. P., Feng, M., Noojipady, P., Anand, A., Huang, C., ... & Townshend, J. R. (2013). Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS vegetation continuous fields with lidar-based estimates of error. *International Journal of Digital Earth*, 6(5), 427-448.

**Examples**

```
## Warnings from GDAL/PROJ are suppressed.

## Brick with structural Essential Biodiversity Variables covering the
## extent of a location in the northern Amazon basin (Colombia):
path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Changes in layers of tree-canopy cover (TC) in the 'amazon'
## brick are computed:
suppressWarnings(
def <- echanges(amazon, eco = 'TC',
                change = 'lossyear',
                eco_range = c(1,80),
                get_unaffected = TRUE,
                binary_output = FALSE,
                mc.cores = 2)
)

## Function 'plotebv' allows comparing rasters using a common scale bar:
suppressWarnings(
plotebv(def)
)
```

---

|                |                                     |
|----------------|-------------------------------------|
| gaugeIndicator | <i>Gauge Biodiversity Indicator</i> |
|----------------|-------------------------------------|

---

## Description

This function processes ecosystem-change maps from [echanges](#) to calculate biodiversity indicators, including ecosystem extent, entropy, fractal dimension, among others. To sample the indicators across fixed-size grids see [sampleIndicator](#).

## Usage

```
gaugeIndicator(ps, ...,
  metric = "area_ha",
  smp_lsm = list(),
  mc.cores = round(detectCores() *
    0.6, 0))
```

## Arguments

|          |   |
|----------|---|
| ps       | SpatialPolygonsDataFrame or RasterStack. Polygon geometry used to produce ecosystem-change maps via the implementation of <a href="#">echanges</a> or the stack of ecosystem-change maps. |
| ...      | If ps is a polygon then additional arguments in <a href="#">echanges</a> or <a href="#">rsp2ebv</a> .   |
| metric   | character. The name of an indicator. Default 'area_ha' computes ecosystem areas (ha) at class level. See the argument 'metric' in <a href="#">list_lsm</a> to implement other metrics.    |
| smp_lsm  | list. List of arguments in <a href="#">calculate_lsm</a> . This argument is ignored when metric = 'area_ha'.  |
| mc.cores | numeric. The number of cores. Default uses around 60 percent of the cores.  |

## Details

Coordinate reference system of the spatial units must have metric units UTM. Performance in the computation of ecosystem extents is optimized via the implementation of the function [tabuleRaster](#). Indicators other than ecosystem extents are calculated implementing [calculate\\_lsm](#).

## Value

tibble.

## Author(s)

Wilson Lara Henao <[wilarhen@gmail.com](mailto:wilarhen@gmail.com)> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

## References

Hesselbarth, M. H., Sciaini, M., With, K. A., Wiegand, K., & Nowosad, J. (2019). landscapemetrics: an open source R tool to calculate landscape metrics. *Ecography*, 42(10), 1648-1657.

O'Connor, B., Secades, C., Penner, J., Sonnenschein, R., Skidmore, A., Burgess, N. D., & Hutton, J. M. (2015). Earth observation as a tool for tracking progress towards the Aichi Biodiversity Targets. *Remote sensing in ecology and conservation*, 1(1), 19-28.

Skidmore, A. K., & Pettorelli, N. (2015). Agree on biodiversity metrics to track from space: Ecologists and space agencies must forge a global monitoring strategy. *Nature*, 523(7561), 403-406.

## Examples

```
## Warnings from GDAL/PROJ are suppressed.

## RasterBrick of structural Essential Biodiversity Variables
## covering the extent of a location in the northern Amazon basin
## (Colombia) is imported:
path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Changes in layers of tree-canopy cover (TC) in the 'amazon'
## brick are computed:
suppressWarnings(
  def <- echanges(amazon, eco = 'TC',
                 change = 'lossyear',
                 eco_range = c(1,80),
                 get_unaffected = TRUE,
                 binary_output = FALSE,
                 mc.cores = 2)
)

## Function 'gaugeIndicator' is used to compute ecosystem areas
## (default):
am_areas <- gaugeIndicator(def,
                          mc.cores = 2)
```

---

getGADM

*Get Geographic Administrative Unit*

---

## Description

This function is a wrapper of [getData](#) used to import levels in Geographic Administrative Data Maps (GADM).



**Usage**

```
getGADM(unit.nm = NULL,  
        level = 2, country = "COL",  
        path = tempdir())
```

**Arguments**

|         |  |
|---------|--|
| unit.nm | character or NULL. Name of an administrative unit (e.g. municipality), or the name of such an unit plus its corresponding higher-level unit (e.g. department/state). If NULL then a list of unit names is printed. |
| level   | numeric. A number between zero and two, indicating any of the levels of administrative subdivisions in GADM (0=country, 1=first level of subdivision, and 2=second level of subdivision).                          |
| country | character. ISO code specifying a country. Default 'COL'  |
| path    | character. Path name indicating where the unit will be stored. Default stores the data in a temporary directory.   |

**Value**

SpatialPolygonsDataFrame or character vector of GADM units..

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**References**

<https://gadm.org/>

**Examples**

```
## Printing municipalities of Colombia:  
  
muni <- getGADM()  
head(muni)
```

---

getrsp *Get remote sensing product*

---

### Description

This function processes the extent of a predefined region of interest (polygon geometry or GADM unit) to download ecosystem remote sensing products (ERSP). Downloadable ERSP include Global Surface Water, Forest Change, and Continuous Tree Cover data. See [listGP](#).

### Usage

```
getrsp(roi = NULL, ...,
       lyrs = NULL, path,
       verify.web = FALSE,
       mc.cores = round(detectCores() *
                        0.6, 0))
```

### Arguments

|            |   |
|------------|---|
| roi        | SpatialPolygonsDataFrame; or character; or NULL. Region of interest. This can be either 1) a polygon geometry; or 2) the name of a GADM unit (see <a href="#">getGADM</a> ); or 3) a NULL value. Default NULL makes the function to print a list of GADM units. |
| ...        | If roi is a GADM unit then additional arguments in <a href="#">getGADM</a> .  |
| lyrs       | character. Remote sensing products. Default NULL makes the function to print a list of Downloadable ERSP, see <a href="#">listGP</a> .  |
| path       | character. Path name indicating where the variables will be stored. Default uses a folder named as 'ecochange' located in a current temporary directory.  |
| verify.web | logical. Verify in the web whether the URLs used to download the rsp are available. See <code>getOption('webs')</code> . Default FALSE.   |
| mc.cores   | numeric. The number of cores. Default uses around 60 percent of the cores.  |

### Details

Downloads of Continuous Tree Cover data require user authentication through the NASA Earth data Login. To obtain a NASA Earth data Login account, please visit: <https://urs.earthdata.nasa.gov/users/new>.

### Value

Path names of the remote sensing products just retrieved, or character vectors suggesting GADM units/Global Products that can be used to download ERSP (see NULL defaults in arguments 'roi' and 'lyrs').

### Author(s)

Wilson Lara Henao <[wilarhen@gmail.com](mailto:wilarhen@gmail.com)> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

## References

- Pekel, J. F., Cottam, A., Gorelick, N., & Belward, A. S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature*, 540(7633), 418-422.
- Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. *science*, 342(6160), 850-853.
- Sexton, J. O., Song, X. P., Feng, M., Noojipady, P., Anand, A., Huang, C., ... & Townshend, J. R. (2013). Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS vegetation continuous fields with lidar-based estimates of error. *International Journal of Digital Earth*, 6(5), 427-448.

## Examples

```
## Warnings from GDAL/PROJ are suppressed.

## Polygon of the Colombian municipality of Cartagena del Chaira:
  load(system.file('cchaira_roi.RData',package = 'ecochange'))

## A Global Surface Water layer ('seasonality') which covers the
## extent of the polygon is retrieved:

suppressWarnings(
  rsp_cchaira <- getrsp(cchaira_roi,
    lyrs = 'seasonality', mc.cores = 2, path = tempdir())
)
file.exists(rsp_cchaira)
```

---

getWRS

*Get WRS*

---

## Description

This function processes regions of interest (a polygon geometry or GADM unit) to find corresponding Landsat Path/Row World Reference System (WRS) polygons. This function is internally implemented by [getrsp](#)

## Usage

```
getWRS(roi = NULL, path = tempdir(),
  ...)
```

**Arguments**

|      |  |
|------|--|
| roi  | SpatialPolygonsDataFrame; or character; or NULL. Region of interest. This can be whether 1) a polygon geometry; or 2) the name of a GADM unit (see <a href="#">getGADM</a> ); or 3) a NULL value. Default NULL makes the function to print a list of GADM units. |
| path | character. Path name indicating where the WRS data are processed.  |
| ...  | Additional arguments in <a href="#">getGADM</a> .  |

**Value**

SpatialPolygonsDataFrame, or set of GADM units.

**Author(s)**

Wilson Lara Henao <[wilarhen@gmail.com](mailto:wilarhen@gmail.com)> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
load(system.file('cchaira_roi.RData', package = 'ecochange'))

wrs_cchaira <- suppressWarnings(getWRS(cchaira_roi))
plot(wrs_cchaira)
```

---

listGP

---

*List of global products*


---

**Description**

This function prints information about ecosystem remote sensing products that can be downloaded with [getrsp](#).

**Usage**

```
listGP(layer = TRUE,
        Algorithm = TRUE,
        author = TRUE, funs = FALSE,
        api.code = FALSE)
```

**Arguments**

|           |  |
|-----------|--|
| layer     | character. Add column 'layer' to the data.     |
| Algorithm | character. Add column 'Algorithm' to the data. |
| author    | character. Add column 'author' to the data.    |
| funs      | character. Add column 'funs' to the data.      |
| api.code  | character. Add column 'api.code' to the data.  |

**Value**

tibble.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**References**

Pekel, J. F., Cottam, A., Gorelick, N., & Belward, A. S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature*, 540(7633), 418-422.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. *science*, 342(6160), 850-853.

Sexton, J. O., Song, X. P., Feng, M., Noojipady, P., Anand, A., Huang, C., ... & Townshend, J. R. (2013). Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS vegetation continuous fields with lidar-based estimates of error. *International Journal of Digital Earth*, 6(5), 427-448.

**Examples**

```
lst <- listGP()
```

---

plotebv

*Plot EBV*

---

**Description**

This function displays level plots for ecosystem remote sensing products using common scale-bars. The function is helpful to visualize patterns in biodiversity indicators.

**Usage**

```
plotebv(ebv, col.regions = rev(viridis_pal(option = "D")(255)),
  ...)
```

**Arguments**

ebv                    Raster\*. Raster Object.  
col.regions            . Color palette. If null then viridis\_pal(option = 'D') is implemented.  
...                     . Further arguments in panel.levelplot()

**Value**

levelplot.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
## Warnings from GDAL/PROJ are suppressed.

## Brick with structural Essential Biodiversity Variables covering the
## extent of a location in the northern Amazon basin (Colombia):
path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Changes in layers of tree-canopy cover (TC) in the 'amazon'
## brick are computed:
suppressWarnings(
  def <- echanges(amazon, eco = 'TC',
                 change = 'lossyear',
                 eco_range = c(1,80),
                 get_unaffected = TRUE,
                 binary_output = FALSE,
                 mc.cores = 2)
)

## Function 'plotebv' allows comparing rasters using a common scale bar:
suppressWarnings(
  plotebv(def)
)
```

---

plotind

*Plot indicator*


---

**Description**

A plot of [gaugeIndicator](#) is printed.

**Usage**

```
plotind(x, labs = list(x = "layer",
                      y = unique(as.character(x$metric)),
                      fill = "class"))
```

**Arguments**

**x** [tibble](#). Data set of indicators such as that produced by [gaugeIndicator](#).

**labs** Further arguments in [labs](#).

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
## Warnings from GDAL/PROJ are suppressed.

## RasterBrick of structural Essential Biodiversity Variables
## covering the extent of a location in the northern Amazon basin
## (Colombia) is imported:
path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Changes in layers of tree-canopy cover (TC) in the 'amazon'
## brick are computed:
suppressWarnings(
  def <- echanges(amazon, eco = 'TC',
                 change = 'lossyear',
                 eco_range = c(1,80),
                 get_unaffected = TRUE,
                 binary_output = FALSE,
                 mc.cores = 2)
)

## Function 'gaugeIndicator' is used to compute ecosystem areas
## (default metric of the function):
am_areas <- gaugeIndicator(def,
                          mc.cores = 2)

## Plot of the output from 'gaugeIndicator'
plotind(am_areas)
```

---

rsp2ebv

*Integrate remote sensing products*

---

**Description**

This function integrates ecosystem remote sensing products and produces raster-data sections with the cell values enclosed in a region of interest.

**Usage**

```
rsp2ebv(ps = NULL, ...,
        lyrs = NULL, path,
        sr, ofr = c(30, 30),
        mc.cores = round(detectCores() *
                          0.6, 0))
```

**Arguments**

|          |  |
|----------|--|
| ps       | SpatialPolygonsDataFrame; or character; or NULL. Region of interest. This can be whether 1) a polygon geometry; or 2) the name of a GADM unit (see <a href="#">getGADM</a> ); or 3) a NULL value. Default NULL makes the function to print a list of GADM units. |
| ...      | If ps is a GADM unit then additional arguments in <a href="#">getGADM</a> can be specified here.   |
| lyrs     | character. Names of the ecosystem earth-observation products. If NULL then a list of products is printed, see <a href="#">listGP</a> . Default NULL.   |
| path     | character. Path name indicating where the variables are stored. If missing then a folder named as 'ecochange' located in a current temporary directory is used.  |
| sr       | character. PROJ.4 description of the target coordinate reference system. If missing then the target layers are projected to metric system UTM.   |
| ofr      | numeric. c(xres,yres). Output file resolution (in target georeferenced units). Default c(30,30) m2.  |
| mc.cores | numeric. The number of cores. Default uses around 60 percent of the cores.   |

**Details**

This function implements 'gdalUtils' so it assumes the user has a working GDAL installation on their system. From the documentation: "If the 'gdalUtils\_gdalPath' option has been set (usually by 'gdal\_setInstallation'), the GDAL found in that path will be used. If nothing is found, 'gdal\_setInstallation' will be executed to attempt to find a working GDAL that has the right drivers as specified with the 'of' (output format) parameter", see example below.

**Value**

RasterStack or list.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**References**

- Jetz, W., McGeoch, M. A., Guralnick, R., Ferrier, S., Beck, J., Costello, M. J., ... & Meyer, C. (2019). Essential biodiversity variables for mapping and monitoring species populations. *Nature Ecology & Evolution*, 3(4), 539-551.
- O'Connor, B., Secades, C., Penner, J., Sonnenschein, R., Skidmore, A., Burgess, N. D., & Hutton, J. M. (2015). Earth observation as a tool for tracking progress towards the Aichi Biodiversity Targets. *Remote sensing in ecology and conservation*, 1(1), 19-28.
- Skidmore, A. K., & Pettorelli, N. (2015). Agree on biodiversity metrics to track from space: Ecologists and space agencies must forge a global monitoring strategy. *Nature*, 523(7561), 403-406.



## Examples

```
## First, we'll check to make sure there is a valid GDAL
## installation (from 'gdalUtils'):

gdalUtils::gdal_setInstallation()
valid_install <- !is.null(getOption("gdalUtils_gdalPath"))

## Warnings from GDAL/PROJ are suppressed.

## A Global Surface Water layer ('seasonality') covering the extent of a
## Colombian municipality Cartagena del Chair i is formatted into an
## spatial EBV:
  load(system.file('cchaira_roi.RData',package = 'ecochange'))

suppressWarnings(
  rsp_cchaira <- getrsp(cchaira_roi,
    lyrs = 'seasonality', mc.cores = 2, path = tempdir())
)

file.exists(rsp_cchaira)

suppressWarnings(
  season_cchaira <- rsp2ebv(cchaira_roi,
    lyrs = 'seasonality', path = tempdir())
)

suppressWarnings(
  plotebv(season_cchaira)
)
```

---

sampleIndicator

*Sample Biodiversity indicator*

---

## Description

This function divides into fixed-size grids each of the scenes of a stack of ecosystem-spatial data and samples a biodiversity indicator by every grid. To compute biodiversity indicators at the class and landscape levels, see [gaugeIndicator](#)

## Usage

```
sampleIndicator(ps = NULL,
  ..., metric = "condent",
  classes = 5, min = 1,
  max = 100, side,
```

```
smp_lsm = list(level = "landscape"),
mc.cores = round(detectCores() *
  0.6, 0))
```

### Arguments

|                       |   |
|-----------------------|---|
| <code>ps</code>       | SpatialPolygonsDataFrame or RasterStack. Polygon geometry used to produce ecosystem-change maps via the implementation of <a href="#">echanges</a> or the stack of ecosystem-change maps.   |
| <code>...</code>      | If <code>ps</code> is a polygon then additional arguments in <a href="#">echanges</a> or <a href="#">rsp2ebv</a> .  |
| <code>metric</code>   | character. The name of an indicator other than ecosystem extent. This can be cohesion ('cohesion'), conditional entropy ('condent'), perimeter-area fractal dimension ('pafrac'), among others, see package <a href="#">list_lsm</a> . Default 'condent'. |
| <code>classes</code>  | numeric; or NULL. Number of evenly spaced classes used to reclassify the layers. Default 5. If NULL then the layers are not reclassified.   |
| <code>min</code>      | numeric. If <code>classes</code> != NULL then minimum cell value in the layers. Default 1   |
| <code>max</code>      | numeric. If <code>classes</code> != NULL then maximum cell value in the layers. Default 100   |
| <code>side</code>     | numeric. Side of the sampling grid (m). If missing the function tries to find a grid size the samples at least a grid with a non-NA value of the indicator.   |
| <code>smp_lsm</code>  | List. Additional arguments in <a href="#">sample_lsm</a>  |
| <code>mc.cores</code> | numeric. The number of cores. Default uses 60 percent of the cores.   |

### Value

Raster\*.

### Author(s)

Wilson Lara Henao <[wilarhen@gmail.com](mailto:wilarhen@gmail.com)> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

### References

- Hesselbarth, M. H., Sciaini, M., With, K. A., Wiegand, K., & Nowosad, J. (2019). landscapemetrics: an open source R tool to calculate landscape metrics. *Ecography*, 42(10), 1648-1657.
- O'Connor, B., Secades, C., Penner, J., Sonnenschein, R., Skidmore, A., Burgess, N. D., & Hutton, J. M. (2015). Earth observation as a tool for tracking progress towards the Aichi Biodiversity Targets. *Remote sensing in ecology and conservation*, 1(1), 19-28.
- Skidmore, A. K., & Pettorelli, N. (2015). Agree on biodiversity metrics to track from space: Ecologists and space agencies must forge a global monitoring strategy. *Nature*, 523(7561), 403-406.

## Examples

```
## Warnings from GDAL/PROJ are suppressed.

## RasterBrick of structural Essential Biodiversity Variables
## covering the extent of a location in the northern Amazon basin
## (Colombia) is imported:
path. <- system.file('amazon.grd',package = 'ecochange')
amazon <- suppressWarnings(brick(path.))

## Changes in layers of tree-canopy cover (TC) in the 'amazon'
## brick are computed:
suppressWarnings(
def <- echanges(amazon, eco = 'TC',
                change = 'lossyear',
                eco_range = c(1,80),
                get_unaffected = TRUE,
                binary_output = FALSE,
                mc.cores = 2)
)

plotebv(amazon)

## Function 'sampleIndicator' is implemented to sample a metric of
## conditional entropy (default):

suppressWarnings(
  def_condent <- sampleIndicator(def, side = 400, mc.cores = 2)
)

plotebv(def_condent)
```

---

tabuleRaster

*Fast tabulation of pixel values*


---

## Description

This function generates frequency tables for scenes in ecosystem remote sensing products by wrapping [rasterDT](#). The function is mapped by [gaugeIndicator](#) to optimize computation of ecosystem extents.

## Usage

```
tabuleRaster(layer = "",
             del0 = TRUE, useNA = "no",
             n256 = FALSE)
```

**Arguments**

layer            character. File path to an ERSP scene.  
del0            logical. Remove the 0-count categories.  
useNA           logical. Include NA values. This argument is passed to rasterDT::freqDT.  
n256            logical. Do the raster contains less than 256 unique values?

**Value**

data.frame.

**Author(s)**

Wilson Lara Henao <wilarhen@gmail.com> [aut, cre], Victor Gutierrez-Velez [aut], Ivan Gonzalez [aut], Maria C. Londono [aut]

**Examples**

```
## \donttest{  
## tabuleRaster(raster(volcano), n256 = FALSE)  
## }
```

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